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HAVELI PROJECT

1935

VOLUME I

REPORT AND FINANCIAL STATEMENTS.



(For official use only)

LAHORE :
PRINTED BY THE SUPERINTENDENT, GOVERNMENT PRINTING PUNJAB
1935

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FROM

J. D. H. BEDFORD, Esq., I.S.E.,
Secretary to Government, Punjab,
Public Works Department, Irrigation Branch,

TO

THE SECRETARY TO THE GOVERNMENT OF INDIA,
DEPARTMENT OF INDUSTRIES AND LABOUR,
PUBLIC WORKS BRANCH, DELHI.

Dated Lahore, the 2nd December, 1935.

Irrigation.
Works.

Subject :—Haveli Project, 1935.

SIR,

I AM directed, by His Excellency the Governor in Council, to submit for sanction an estimate amounting to Rs. 5,35,75,000 of the probable cost of the Haveli Project, 1935.

Volume I of the 1935 project contains the report explaining the scope, the intentions, the main technical points involved, and the financial statements prescribed in Appendix V of the Public Works Department Code (1931).

All details regarding water supplies in the 1935 project, expenditure estimates, maximum flood discharges, forecast of probable irrigation, revenue forecast from the various units, and the programme of construction and establishment required are given in Volume II. Abstracts of costs by units along with main details are given in Appendix B-II, Volume II. The main points pertaining to the expenditure estimates have been explained in Appendix B-I, Volume II.

The project is designed to irrigate the land lying along the banks of the Chenab below the junction of the Chenab and Jhelum. It will take up the Chenab Inundation Canals area as well as the area at present served by the Sidhnai system.

2. It will be recalled that an estimate for the Haveli project was submitted with Punjab Government's letter No. 01308-W. I., dated the 10th September, 1915, but was returned unsanctioned with Government of India's letter No. 428-I., dated the 19th May, 1916, owing to the objection of the Bahawalpur State that the project if executed would adversely affect the Bahawalpur State inundation canals. This objection has since been removed by the construction of the Panjnad weir and canal, which takes up all the area previously irrigated by the Bahawalpur Inundation canals.

3. Owing to the construction of the Sukkur Barrage project certain limitations were placed by the Government of India and the Secretary of State on the extent of further withdrawals from the Indus and its tributaries.

In March, 1929, the Indus Discharge Committee agreed to a *rabi* supply of 1,250 cusecs being made available for utilization in the Punjab for the Haveli project.

The project was consequently prepared to utilize the restricted *rabi* supply of 1,250 cusecs, but it was found that the scheme would not be productive as a supply of 2,500 cusecs would not insure an adequate supply in October and November and again during March to enable sufficient areas to be sown and matured as would produce a minimum return to make the project remunerative. This project was, therefore, held in abeyance for a more favourable allotment of winter supply to the Punjab in the above critical months.

4. The problem of a more liberal winter supply to the Haveli was taken up in the Committee of the Central Board of Irrigation on distribution of the Waters of the Indus and its Tributaries held in March and June, 1935. The Committee in their report, Volume I, page 20, Table II, have recommended a withdrawal of 2,750 cusecs during October and March and mean withdrawal of 2,475 cusecs during November. The project now submitted is strictly in accordance with the recommendations of this Committee, which, it is assumed, will be accepted by the Local Governments and Durbars concerned.

5. In the Government of India's letter No. 428-I., dated the 19th May, 1916, referred to in paragraph 2 above, it was suggested that there was no reason why credit should not be taken in the project for irrigation done by "that portion of the cold weather supply in the Ravi which will be set free at Balloki." At that time it was proposed to use this supply for increasing irrigation on the Lower Bari Doab canal, but it is now considered, as explained in paragraphs 10 to 13 of Volume I of the 1935 Project, that this water could be utilized to the maximum advantage on the Pakpattan perennial canal and on the Burala Branch Extension. It may be mentioned here that at the Delhi Water Committee, 1935, the Punjab, in the interests of an amicable settlement with the Bahawalpur and the Bikaner States, agreed to give up a share of the Sutlej *Ghara* supply to which it felt itself entitled. In the 1935 Haveli project the opportunity has been taken to make up this shortage on the Pakpattan canal by utilization of the greater portion of the Ravi water set free at Balloki, by means of a link from the Lower Bari Doab canal to the Pakpattan canal as shown in the Index plan, No. 6 contained in the folder of right hand cover of Volume I.

6. The scope of the project is given in paragraphs 4 and 14 of Volume I of the 1935 Project. The new Haveli canals will provide a probable perennial irrigation of 518,344 acres in a gross area of 694,278 acres, and a probable non-perennial irrigation of 452,000 acres in a gross area of 862,549 acres. The capital cost is estimated to be 536 lacs giving a net return of 7.8 per cent. in the tenth year after construction.

7. The project now submitted is based on actual designs and estimates prepared in accordance with up-to-date irrigation practice, and has been thoroughly examined and approved of by all the three Chief Engineers in the Punjab. It is, therefore, not considered necessary to send up to the Government of India these detailed plans and estimates. The estimate is liberal compared with the Sutlej Valley project costs, and there is no likelihood of the project being exceeded.

8. His Excellency the Governor in Council recommends the project as now submitted for very early sanction to relieve the difficulties experienced at present not only on the Sidhnai canals, but on the Chenab Inundation canals, as well. On these canals the percentage of crops that do not come to maturity at present is abnormally high. This causes a serious drain on the general prosperity of the people in this tract as well as on the revenues of the Punjab Government.

I have the honour to be,

SIR,

Your most obedient servant,

J. D. H. BEDFORD

Secretary to Government, Punjab,
Public Works Department, Irrigation Branch.

Enclosures—

The 1915 Project.

The 1932 Project.

Haveli Project, 1935, Volumes I and II.

Report on the Haveli Project of 1935,

BY

MR. J. D. H. BEDFORD,

Chief Engineer, Irrigation Works, Punjab.

Dated the 18th July, 1935.

PART I.—GENERAL:

1. In the Punjab, the original project for a canal does not come to fruition. For various reasons, it is held up and forgotten for a few years, but if the project is intrinsically sound, it crops up again and again until eventually it is sanctioned—often in a more elaborate form, and always in a more expensive form.

2. *The 1915 Project.*—This report may be read in conjunction with Appendices (Vol. II) and maps in the cover. The 1915 project was made by Mr. F. M. Purves, Temporary Engineer. The estimated cost of the project was Rs. 1,70,00,000. It consisted of an old type weir below the junction of the Jhelum and the Chenab with offtaking right and left bank canals. The left bank canal was to tail into the Ravi immediately above the present Sidhnai headworks, and a new connecting link was to take out from the left of the Ravi to link up the existing inundation channels offtaking from the left bank of the Chenab, below its junction with the Ravi. The right bank canal was to take up the low lands that were available for irrigation and to tail into the Karam canal; no attempt was made to feed the Ganosh and Taliri from the proposed canal owing to the unsuitability of the terrain through which the connecting link must pass. The proposal was to do the minimum amount of work required to enable the undoubted supplies below the junction of the Chenab and Jhelum to be utilized in the existing Chenab and Ravi canals, and in new distributaries to be constructed under the scheme. This project was calculated to show a return of 5.63 per cent.

3. *The 1932 Project.*—The next project was made in 1932. The main differences between this and the 1915 project were as follows:—

The right bank canal was to be extended through the uplands of the Thal to link up with the existing Ganesh and Taliri inundation canals on the right bank of the Chenab. To make this link, it is necessary to go through the Thal area, because the river lies so close up to the Thal that there is no riverain land available in which to construct the canal required to link up with the Ganesh and Taliri.

On the left side, the alignment of the connecting canal between Trimmu, the proposed headworks on the Chenab, and Sidhnai on the Ravi, was altered so as to drop into the Ravi quite close to the Abdul Hakim railway station and about 4 miles upstream of Sidhnai headworks. Sidhnai was to be abandoned and a new headworks built near Abdul Hakim and the connecting canals were proposed to run parallel to the Ravi until they reached Sidhnai and dropped into the existing canals—the proposed Multan feeder connecting up the inundation canals on the left bank of the Chenab remaining more or less as in the 1915 project.

The cost of the 1932 project had increased from Rs. 1,70,00,000 to Rs. 5,79,00,000 and a profit of 5.63 per cent. was converted into a loss of Rs. 18 lacs per annum.

4. *The 1935 Project.*—The gross areas served in the 1935 project are approximately the same as in the 1932 project though the proposed irrigation in the 1935 project is considerably more because of the better winter supplies provided.

The statement below gives in brief the scope of the project as regards areas to be served and irrigated :—

Classification of areas.	PERENNIAL			NON-PERENNIAL		
	Gross area.	Probable area of irrigation in the tenth year.	Existing canal irrigation (ten years' average).	Gross area.	Probable area of irrigation in the tenth year.	Existing canal irrigation (ten years' average).
1	2	3	4	5	6	7
Proprietary areas within present irrigation boundary	Acres. 510,715	Acres. 410,920	Acres. 355,000	Acres. 420,120	Acres. 278,411	Acres. 109,000
New proprietary areas	28,740	21,839	Nil	377,705	161,849	Nil
New Crown waste areas	154,823	80,585	Nil	64,724	11,700	Nil
Total ..	694,278	513,344	355,000	862,549	452,000	199,000

In Crown waste areas, credit for irrigation is taken only for better lands, as ascertained from a detailed soil survey.

For estimating purposes also, the 1935 project is the same in scope as the 1932 project, though there are two points which require more detailed consideration before construction commences :—

- (a) It is not fully established that the construction of a new headworks at Abdul Hakim, 4 miles upstream of Sidhnai on the Ravi, is really essential.
 - (b) It is doubtful whether the extension of the right bank canal to feed the Ganesh and Talari is sound.
- The project has been so framed that the final omission of (a) and (b) will make it more productive ; hence there appears to be no objection to the inclusion of these two items.

5. *Water supplies in the 1932 Project.*—The 1932 project dealt with a winter supply of 1,250 cusecs and a summer supply of 7,500 cusecs. The winter supply was limited to what other interested parties were prepared to allow the Punjab to draw off. Both this and the 1915 projects did not take into account the money value of the water at present going down the Ravi below Balloki for the Sidhnai canals. It may be necessary to explain here that the Sidhnai canals taking off from the Ravi are, at present, fed with the Ravi water, which is not taken off by the Lower Bari Doab canal at Balloki, being reserved for the Sidhnai ; when the barrage is built at Trimmu, the Sidhnai and subsidiary canals will be fed by the Chenab water, and the Ravi water at present reserved for the Sidhnai canals will be available for use elsewhere.

6. *Reasons which allow of a successful 1935 Project.*—It is entirely due to the fact that this water can be utilized in the existing canals of the Punjab that the 1935 Haveli project can be made a possible proposition. The total cost of the 1935 project is Rs. 5,35,75,000 and the capitalised value at 6 per cent. of the Ravi water made available at Balloki is Rs. 3,50,00,000. Hence the net capital for which new revenue is required from the areas covered by the Haveli project itself, is relatively small compared with the total cost of the project, and is approximately the same as that required for the 1915 project, which showed a return of 5.63 per cent.

7. *Water in the 1935 Project in accordance with the Delhi Committee Recommendations (see Vol. II, Appendix A-I).*—During the past few months, a Committee, ordered by the Government of India, consisting of representatives from the Punjab, Sind, Bahawalpur, Bikaner and the North-West Frontier Province and of two independent members, sitting at Delhi and Simla, have made recommendations for the distribution of the waters of the Indus and its tributaries between Sind, Bahawalpur, Bikaner and the Punjab.

The supplies of water, on which the 1935 project is based, are strictly in accordance with these recommendations, hence there should be no likelihood of either Sind or Bahawalpur or Bikaner objecting to the construction of this project on the grounds that it will affect their rights.

8. *Source of water supplies in the 1935 Project.*—During the winter months, with the exception of occasional freshets, the water supply, on which this project is based, is entirely infiltration water, i.e., water which seeps into the Jhelum, the Chenab and the Ravi during the winter months, when water levels in the rivers are low. According to the records of such discharges, maintained by the Discharge division during the past 12 years, these supplies are very considerable.

9. *Capacities of canals in the 1935 Project.*—The capacities proposed for the Haveli canals are as follows:—

	Cusecs.
Perennial capacity	2,750
Non-perennial capacity	5,000
Total capacity	7,750

The actual mean supply which will be utilized against the above capacities during the winter months will, of course, be less than 2,750 cusecs. While every effort will be made to restrict supplies during the months of December to February so as to encourage the continued use of wells, the Punjab reserves to itself the right to utilize its full share of water in the Chenab. The details of supplies, on which the proposed irrigation figures have been based, are dealt with in full in Appendix A-I, and will not be considered further in this general note. It will be sufficient to state that the supplies to be utilized will be strictly in accordance with agreements with Bahawalpur and Sind.

10. *Considerations governing use of the Ravi water made available at Balloki.*—The Ravi water, which at present is reserved at Balloki and passed down the river to the Sidhnai headworks, will no longer be required for the Sidhnai canals; and is thus available for use elsewhere. In the winter, this water is largely regeneration water from above Balloki and is available at Balloki (see Vol. II, Appendix A-II, for details). It is, therefore, clear that if it can be taken off directly from Balloki, it will be used with the minimum amount of expenditure and disturbance of existing arrangements. A further very important consideration was, if possible, to utilize this water on Crown lands, because the revenue obtainable would then include rents or interest on sales of Crown lands in addition to the usual land revenue and water rates obtainable.

A search was, therefore, made to find the best use for this water.

11. *Causes that contribute to the success or failure of canal projects.*—The least successful of the Punjab projects is the latest, viz., the Sutlej Valley project. There is only one basic reason for its comparative failure, i.e., shortage of water supply. There is insufficient water in both the summer and winter sowing seasons and throughout the winter to cope with the lands served by the Sutlej Valley canals.

All other reasons, such as the increased cost of construction, the depression in agriculture, are trivial compared with that basic fact—shortage of water. Without water no project can be successful. On the Sutlej Valley Pakpattan perennial canal, there exists a large area of nearly 1 million acres of Crown waste land served by an inadequate supply of perennial water. About 370,000 acres of this land have been reserved for sale to capitalists. At present such sales are at a stand-still and the canal development is much retarded. The world depression has had something to do with it, but the main cause is, undoubtedly, an insufficient supply of water. If it were possible to increase the supply appreciably, there is no reason why the Pakpattan canal should not be highly successful.

12. *Utilization of the Ravi water at Balloki recommended by author in the Pakpattan perennial canal.*—In connection with this Haveli project, an opportunity has arisen. Water will be available at Balloki. The officers of the Lower Bari Doab canal are satisfied that 700 cusecs can be passed down this canal in addition to its full existing requirements. It, therefore, occurred to the writer of this note that it would be extremely profitable to pass a discharge of 700 cusecs down

to within a few miles of Montgomery, and to take it out into a feeder which will cross the Sukh Beas, and drop it into the Pakpattan perennial canal near Dilu-wala rest-house. The connecting link was surveyed in full detail and was found to be entirely feasible, and to present no engineering difficulties. The cost of the works required for this link is presented in Unit No. 5 of this project and is 11.96 lacs of rupees. The forecast of yearly revenue from this water is 15.54 lacs of rupees, *i.e.*, revenue will more than pay for the link in one year. It is this link providing for the very profitable use of the spare water at Balloki which makes the Havoli project possible. The water required for the link and the Burala Branch Extension is all Ravi water saved from Sidhmal canals, but until the Trimmu headworks are completed there appears to be no reason why the Punjab should not transfer a part of the share in the Chonab river allocated to it, to this link, *via* the Upper Chenab canal. Further, if we would be meticulous in calculating the revenue from the link, we can add to its cost 9% of the estimated cost of Trimmu headworks, *i.e.*, 21 lacs. We will then obtain 15.5 lacs net revenue on Rs. $21 + 11.96 = 32.96$ lacs capital expenditure, and a return of 48 per cent per annum.

The water will be used entirely on the Crown waste areas. No portion of it will be given to proprietary areas. The proprietary areas at present getting perennial irrigation from the Pakpattan have been extremely well treated inasmuch as they have been given a perennial supply where such did not exist in the past. This perennial supply has caused a considerable rise in the capital value of these proprietary lands, and Government has taken no tax on such unearned increments. Hence there is no reason why any portion of this additional and very valuable water should be dissipated on proprietary areas.

The supply to be given to the Pakpattan perennial has been limited to 700 cusecs, as this is the largest supply that the Pakpattan Crown waste area can use with the maximum efficiency. It also happens to be the largest supply which the Lower Bari Doab canal can pass down to near Montgomery without considerable expense on enlarging the canal.

13. *Balance of the Ravi water at Balloki to be used in the Burala Branch Extension.*—The balance of water available at Balloki can be used to make the Burala Branch Extension perennial. The Burala is one of the many branches of the Lower Chenab canal. The first job, the author of this note was put on to, when he joined the service in 1905, was the surveys in connection with the scheme of extending the Burala branch. The Lower Chenab canal is an enormous canal and when originally constructed, it is possible that the originators of the scheme from sheer fatigue omitted to extend the Burala branch to irrigate all the virgin areas lying in its tail reaches. A scheme for extending the Burala branch as a perennial canal was made in 1905, but was held in abeyance owing to the uncertainty as regards water supplies in view of the proposed Triplo canals project then under consideration. When the Triple canals project had been completed, the Burala Branch Extension scheme was revived, and the writer made the revised estimate which was sanctioned. While the work was under construction, considerable political agitation was aroused with a view to stop winter supplies being given to the extension areas on the ground that it was merely taking water from the existing areas and giving it to the new areas. The Burala Branch Extension was, therefore, converted into a non-perennial canal, *i.e.*, water was supplied throughout the summer months, when it was spare in the river. Leaving aside the impossibility of obtaining good agricultural development with such a restricted supply, it is also hydraulically very inconvenient, because during the summer months, the main canal has to bring larger supplies down a distance of more than 100 miles to this Extension. During the winter months, the supplies are much lower, and this fluctuating supply makes it more difficult to keep the canal in good regime. The opportunity has now arisen to make the Burala Branch Extension perennial, as was originally intended. The extra water given to it will, of course, be Chenab water, but the Lower Bari Doab canal can use the equivalent supply of Ravi water for its own purpose and a reduced supply will be sent down to Balloki along the Upper Chenab canal in view of the extra supply given to the Burala Branch Extension. It is good business to make this scheme perennial as most of the land on it is Crown waste. The sales value of such lands increases very appreciably, if the land is given perennial water supply.

As stated in a previous paragraph, the capitalised value of the water used on those two schemes represents Rs. 8,50,00,000 or $\frac{2}{3}$ rd of the total cost of the Haveli project.

14. *Summary of the scope of the 1935 Project.*—The 1935 Havoli project then consists of three distinct parts :—

- (a) The construction of a link between the Lower Bari Doab canal near Montgomery and the Pakpattan perennial canal. The object of the link is to give an additional supply to Crown waste areas in general, and particularly to those areas not yet sold, so as to increase the yearly intensity of irrigation and to make the areas more marketable.
- (b) The giving of a winter water supply to the Burala Branch Extension areas of the Lower Chenab canal.
- (c) The building of a barrage below the junction of the Chenab and the Jhelum, so as to utilize the winter infiltration and summer waters of the combined river to give controlled and better perennial irrigation to the Sidhnai canals offtaking from the Ravi, and non-perennial controlled irrigation to the inundation canals taking out of the Chenab, and also to irrigate some new areas which in the past have had no irrigation facilities.

The water required for (a) and (b) can only be made available if (c) is constructed, and the surplus revenue obtainable particularly from (a) and also from (b) makes it possible to class (c) as productive. It is clear, therefore, that the three parts cannot be separated but form one scheme.

15. *Financial results.*—The financial statements attached at the end of this report show that the project will give a net return of 7·8 per cent. on the capital at charge in the tenth year of the opening of the canals. The project can, therefore, be classed as productive according to Public Works Accounts Code, Appendix 4, page 178.

In case the Montgomery-Pakpattan Link is not constructed the project is estimated to pay 4 per cent., and this without taking into full consideration the money value of the Ravi water, which will be set free at Balloki, by the construction of the Trimmu headworks.

Statement I gives the forecast of probable direct expenditure year by year.

Statement II shows the indirect charges required for audit and accounts, and for the capitalization of abatement of land revenue,—*vide* paragraph 12 of Appendix V, Public Works Department Code (1931).

Statement III gives the estimate of revenue receipts and charges for all the units of Haveli project.

Statements IV and V show the net financial results upto the tenth year after the completion of the project, excluding and including the indirect outlay respectively.

Statement VI has been prepared for the purposes of assessing the productivity of the project in the light of Appendix 4, page 178 of Public Works Accounts Code. It shows the sum at charge, cumulative net revenue and interest, and the percentage return on the sum at charge, year by year.

The project will be financed from loans.

16. *Appendices.*—All the various points that go to make up this project have been dealt with in a general manner in the remaining parts of this report and in detail in the Appendices printed as a separate volume. As far as possible, each appendix has been made self-contained even at the cost of some repetition, hence the authority studying this project will be able to find in the letter press any aspect of the project without delay.

PART II.—ESTIMATES AND TECHNICAL DETAILS.

(See Vol. II, Appendix B-II for details of estimates.)

UNIT No. I.—TRIMMU HEADWORKS.

17. *Maximum flood discharge in the Chenab.*—There has been controversy in the past about the maximum flood discharge to be accepted at the Trimmu headworks site for project purposes. This question has been fully treated in

Vol. II, Appendix C-I, and we can safely accept 650,000 cusecs as a maximum outside figure for the flood discharge at Trimmu. This compares with a flood discharge of 700,000 cusecs for which the Panjnad headworks has been designed. In the 1932 project, this figure of $6\frac{1}{2}$ lacs was accepted for Trimmu and an addition of 20 per cent. was made for local concentration in the waterway allowed for the barrage, and a very detailed design was made for a barrage of 54 bays of 60 feet span *plus* 24 bays of 30 feet span for depressed undersluices. This compares with 47 bays of 60 feet span and no undersluices as provided for Panjnad. For estimating purposes the design for this unduly large barrage has been allowed to stand with slight alteration. A consideration of the problem, however, shows that no addition to the number of spans can make a barrage safe against local concentration. The wider a barrage is built, the more scope there exists for the formation of islands on the upstream side. These islands mask the approach to many of the bays and the local concentration will occur, however wide the barrage is made; in fact, a barrage that is too wide may, in practice, result in greater local concentration than a more restricted barrage. Local concentration can only be catered for by adequate protection on the upstream and downstream of the barrage and this adequate protection has been provided in the estimate.

18. *Waterway required for the Trimmu barrage.*—In such matters, one existing barrage as an example is worth much more than mere theory. The Panjnad barrage is under the jurisdiction of the author, and he knows that the waterway of 47 bays of 60 feet span is liberal and the barrage is a loose one. The maximum flood discharge to be passed at Trimmu is much the same as at Panjnad, and it will, therefore, not be necessary to provide a greater effective waterway for Trimmu than has been provided for Panjnad. Undersluices at both ends of a barrage are a convenience and have been provided for Trimmu in the 1935 estimate. It follows, therefore, that when Trimmu barrage comes to be constructed, it will not consist of more than 40 bays of 60 feet span *plus* 16 undersluice bays of 30 feet span, 8 being at each end. The estimate allows for 54 bays of 60 feet span *plus* 16 undersluice bays of 30 feet span. The cost of one bay of 60 feet span is 1.25 lacs of rupees. The cost of Trimmu headworks has, therefore, been over-estimated by 17.5 lacs of rupees on this one item alone.

19. *Cost of the Trimmu headworks compared with the Panjnad.*—In estimating the probable cost of the Trimmu headworks, we are fortunate in having as a guide the recently constructed Panjnad headworks. The Panjnad headworks have been built downstream of the Chenab and the Sutlej—the Chenab being the combined Jhelum and Chenab and the Sutlej, the combined Beas and Sutlej. Panjnad has been built to pass a flood discharge of 700,000 cusecs; Trimmu is required to pass 650,000 cusecs. Trimmu barrage also is to be built immediately below the junction of two rivers, the Jhelum and the Chenab. There is thus a very real similarity between the two headworks. It is expected that there should be a similarity in cost. The Trimmu barrage was estimated in the 1932 Haveli project to cost Rs. 8.29 crores as compared with the actual Panjnad cost of Rs. 1.89 crores. It is clear that such a big difference cannot be due to mere variation in design. The main reason for the unduly heavy estimate in 1932 is an allowance of 47 lacs of rupees for spurs provided along the Chenab and the Jhelum for several miles upstream. There is no indication at present that such spurs will be required. Panjnad has been in existence for several years, yet up to this time, no spurs have been required upstream of it. In the 1935 project, allowance has not been made for such spurs.

The 1935 project does not contain provision for depressed bays in the centre of the barrage. These central depressed bays have not been found an unmixed blessing at Islam headworks, and are suspected to have encouraged prolific berm growth along the upstream flank walls, causing difficulty in feeding the right bank canal.

A change in alignment and shortening of the canal railway, the deletion of allowance for hydro-electric generation at the expense of the project, and a very moderate reduction in rates have also helped in reducing the estimated cost of the Trimmu barrage from Rs. 9.29 lacs in 1932 to Rs. 2.30 lacs in 1935. This 2.30 lacs compares with 1.89 lacs actual cost for Panjnad. As explained above, the 1935 project is estimated liberally regarding waterway provided and

in addition the project rates for works are generous. In all probability, there will be substantial savings on Unit No. I, when work is completed.

20. *Reasons for liberal expenditure estimate for Trimmu headworks.*—The Punjab had an unfortunate experience on the Sutlej Valley project inasmuch as the original sanctioned estimate was very heavily exceeded. It is with the express object of avoiding similar excesses in this project that the Trimmu headworks have been liberally estimated to the extent of 30 to 40 lacs of rupees. There is another advantage in making liberal allowances on the expense side, viz., it results in the revenue forecast being more conservative on probable actual costs. The Punjab desires to avoid under-estimating the cost of a project or over estimating the receipts therefrom.

UNIT No. 2.—ABDUL HAKIM HEADWORKS.

21. *Maximum flood discharge in the Ravi.*—Unit No. 2 is the estimate for the Abdul Hakim barrage on the Ravi, 4 miles upstream of the present Sidhnai headworks. The data on which the proposed flood discharge of 81,000 cusecs has been accepted, is very fully discussed in Appendix C-II, Vol. II.

22. *Pros and cons of building a new headworks at Abdul Hakim.*—The pros and cons of building a new headworks on the Ravi as against remodelling or utilizing the existing Sidhnai headworks have been considered in past years from time to time. The 1932 project allowed for a new headworks. It is estimated to cost Rs. 39 lacs—a considerable sum of money: the additional area for which irrigation can be provided is restricted and merely consists of a thin high strip along the banks of the Ravi.

It may be explained that the Ravi has, in the course of years, raised its bed in this reach so that it is flowing not in a valley but on a ridge, and there is something to be said against any further ponding up of supplies in this river. In the project, however, the cost of constructing this additional headworks at Abdul Hakim has been included, because it is quite possible that further intensive examination may prove it to be necessary, but if it is found that the construction of the headworks can be avoided, this will be done; and the financial returns of the remaining project will prove to be no less favourable.

The estimate is based on a detailed drawing of the proposed barrage and the various items comprising it have been very fully calculated.

UNIT No. 3.—LEFT BANK CANALS.

23. *Scope.*—The works provided for in this unit consist of all the canals and distributaries that are required on the left bank of the Chenab. The main canal starts at Trimmu and joins the Ravi at Abdul Hakim, 4 miles above the present headworks at Sidhnai. A certain amount of new Crown waste area will be taken up to the north of the Ravi and a branch canal will be provided to do non-perennial irrigation on the left bank of the Chenab.

24. *The main canal.*—The main canal from Shorkot Road station to Abdul Hakim runs parallel and close to the North-Western railway and is in extremely high embankment. The full supply levels attain a height of 15 feet above natural surface level. The danger from breaches is, therefore, real and breaches will be particularly harmful as the canal is so close to the railway line, also such breaches would be an additional factor causing waterlogging; hence the detailed estimate allows for reinforced brick masonry core-walls to be built in the centre of each bank. These core-walls will safeguard the railway and the surrounding country from damage.

It is proposed to excavate the canal upstream of Shorkot Road railway station by means of second hand dragline steam excavators. These excavators were used on the Sutlej Valley project, and are available at a nominal price. Only the steam-driven ones will be utilized because in out of the way places the mechanism of steam-driven plant is better understood than that of Diesel electric plant.

25. *Allowance for surface drainage.*—A separate estimate was made for lining the bed of the canal in the high filling reach, because it is felt that there may be considerable trouble from waterlogging owing to the big head of water in the canal. It was, however, decided to omit the bed lining and to provide, instead, a liberal allowance for surface drainage, which has been done.

In the earlier projects, little, if any, allowance was made for a drainage system. The 1935 project is in advance in this respect inasmuch as adequate allowance has been made for very complete surface drainage.

26. *Sidhnaï perennial and Multan non-perennial canals.*—On the left bank of the Ravi, allowance has been made for separate perennial and non-perennial canals to link up with the existing Sidhnaï canal, 4 miles below, and with the newly proposed non-perennial Multan branch. A distributary has been provided on either side of these two main canals. This makes four channels running parallel to one another for a distance of 4 miles..

The non-perennial Multan branch will link up all the present inundation canals on the left bank of the Chenab except the Belochwah, which lies to the extreme south in the fork of the Sutlej and the Chenab. The Belochwah operates in an area of very high sub-soil levels and hence does not require weir controlled irrigation.

In addition to the above new works, some of the existing distributaries of the Sidhnaï canal will be extended to take up new areas as indicated on the plan. There will also be general remodelling of the existing channels to make them more efficient.

27. *Rates.*—The rates for work in Unit No. 3 have been very carefully considered and are believed to be adequate. It is this increase in rates and also increase in quantities that has resulted in the 1935 project estimate for Unit No. 3 being Rs. 45 lacs more than the estimate of 1932.

UNIT No. 4.—RIGHT BANK CANAL.

28. *Scope.*—The project allows for a canal to deal with the present riverain unirrigated areas on the right side of the Chenab in the upper reaches of the canal and the Karam canal areas, and also to be extended downstream to feed the Ganesh and Taliri canals which serve the areas around Muzaffargarh. There is real difficulty in extending the proposed canal beyond the Karam canal areas, because here the river is lying up against the high lands of the Thal. The Thal is a sandy desert and the canal for some miles would have to be taken through this desert in deep digging. It will not be easy to keep the channel open during the summer season and while it will be quite feasible to make a canal connecting the Ganesh and the Taliri, it is probable that it may not function satisfactorily. The project, however, allows for the full cost of making this link.

29. *Linking up of the Ganesh and Taliri canals.*—It has been argued that when the headworks are built at Trimmu, the Ganesh and Taliri inundation channels will suffer owing to the diminution of supplies in the river. The Chenab, however, is a river that rises early in April and very rapidly. In accordance with the proposed agreement between Sind, Bahawalpur and the Punjab, the draw off up to the middle of April will be restricted to the rabi capacity of 2,750 cusecs until there is surplus water at Sukkur, and the withdrawal of such a small quantity of water will make little difference to waterlevels in the river opposite to the Ganesh and the Taliri heads. Even so, under normal conditions, it can be argued that there will be some difference. The conditions are, however, abnormal inasmuch as within the last few years a barrage has been built at Panjnad, at a distance of 60 miles downstream. It is an accepted fact that the erection of an obstruction across a river results in a permanent rise in bed levels upstream, this rise becoming more evident with the passage of years. It is, therefore, conceivable that a rise in bed levels opposite the heads of Taliri and Ganesh may neutralize the small drop in water levels due to withdrawal of water at the Trimmu headworks. This is a matter that will require careful investigation before the Punjab embarks on the construction of the link with the Ganesh and the Taliri. The financial forecast of revenue to be obtained from this link has been, deliberately, minimised so that if the construction of the link in the lower reaches were to be abandoned or postponed, the financial effect on the project will be negligible.

UNIT No. 5.—MONTGOMERY-PAKPATTAN LINK.

30. *Costs based on detailed surveys and designs.*—The estimate in this unit provides for the cost of a channel connecting the Lower Bari Doab canal, 3 miles upstream of Montgomery and the Sutlej Valley Pakpattan perennial canal. The alignment has been very thoroughly surveyed on the ground.

The estimate is fully detailed to an extent that the individual estimates can be used as detailed construction estimates. The earthwork has been fully calculated and the areas of land worked out in detail. Detailed drawings and estimates have been made of masonry works. The project cost of this link can, therefore, be accepted with confidence.

The canal link, merely, consists of a connecting or feeder channel. The water is dropped into the existing Pakpattan perennial canal and will be used in the existing irrigating distributaries. The irrigation done will be recorded by the existing staff; hence the maintenance cost will be limited to that of the link only.

31. *Expenditure not required for Burala Branch Extension.*—Although the project takes credit for revenue from the Burala Branch Extension, it does not include an expenditure estimate for the Extension because none is needed. The Extension was sanctioned some years back and the work has been completed and is functioning at present as a non-perennial canal, i.e., the canals are closed during the winter months. When water is made available during the winter, the canals will function the whole year round. The maintenance and irrigation recording staff are kept on all the year, hence the capital expenditure will be nil. A small amount of additional maintenance expenditure will be necessary and this has been provided.

PART III.—REVENUE FORECAST.

32. In dealing with this problem, it was necessary to make three financial forecasts :—one for the Montgomery-Pakpattan link, one for the Burala Branch Extension, and one for the Haveli canals area. Full details of the data and the considerations affecting these forecasts are given in Vol. II, Appendices E-I to E-VI. The main considerations are briefly sketched below :—

33. *Forecast of winter irrigation on the Haveli canals.*—The mean water supply available in the winter months has been forecast on the average of the last 12 years discharges. In the winter, the actual supply available is very much less than the authorised capacity of the canals. It was felt that a forecast of winter irrigation, based on capacities of canals, may result in erroneous results, because the actual supplies do not bear the same relation to capacity on this canal as on others. It was, therefore, decided to base the forecast on the irrigating capacity of a cusec-day during the sowing period of the winter crops, i.e., from the 16th October to the 10th December. The irrigating capacity of a cusec-day in the neighbouring Khanewal and Jhang perennial divisions of existing canals was used as a guide. The figure of 2.8 acres per cusec-day accepted for the forecast is definitely conservative, as compared with the irrigation being obtained from a cusec-day in the Jhang and Khanewal divisions and the Sidhnai canal at present. (See Vol. II, Appendix D-I).

34. *Forecast of summer irrigation on the Haveli canals.*—In the summer, there will be sufficient water to meet all demands; hence a forecast based on capacities will probably give fairly accurate results. A figure of 80 acres per cusec capacity at distributary head was decided upon, after a study of the results being obtained in the neighbouring irrigation divisions, and also on the Sidhnai canal. This figure is a conservative one. The figures for proposed irrigation were reviewed by the other two Chief Engineers. Certain modifications suggested by them have been given effect to in the actual figures taken in the financial forecast.

35. *Intensity of annual irrigation in the Haveli canals area.*—In Appendix D-I, a statement (No. VIII) is given, showing details of gross and culturable areas and probable annual irrigation in the Haveli tract. It will be seen that the annual perennial irrigation comes to 74 per cent. of the gross area and 89.4 per cent. of the net culturable irrigable area. The non-perennial irrigation on the left and right banks comes to 65.5 and 38.0 per cent. respectively, of the gross area.

The yearly perennial irrigation of 89.4 per cent. of the net culturable is in no way excessive; in fact, this percentage is about correct for prosperous farming on canal irrigated lands with low rainfall. Any serious reduction in this percentage results in slow development and unpopularity of the canal in question. Our most successful canals are the Lower Chenab canal—the intensity of annual irrigation is about 95 per cent., the Lower Bari Doab canal—the

intensity of irrigation being about 88 per cent., the Upper Bari Doab canal—the intensity of irrigation being about 90 per cent., so that this project follows established and successful practice. We departed from this practice on the Sutlej Valley project and the results have not been entirely happy. A low percentage of annual irrigation is successful only in districts, where the average rainfall is sufficient to allow of crops being grown in the remaining areas, without the aid of canal water. In the Haveli tracts, rain-sown-crops are unknown.

36. *Forecast of irrigation on the right bank canal.*—In a previous paragraph, it has been stated that the revenue receipts, forecast from the right bank canal, had been kept moderate, so that the omission of the connecting link for the Ganesh and Taliri would not adversely affect the financial stability of the project as a whole. This is clearly brought out in the comparatively low percentage of irrigation shown for the right bank canals.

37. *Forecast of irrigation on the Montgomery-Pakpattan Link and the Burala Branch Extension.*—The data utilised for forecasting the probable irrigation in the Haveli canals tract has been applied to forecasting irrigation on the Pakpattan Link and the Burala Branch Extension, though on these two canals, we are likely to get somewhat better results than on the Haveli because of the greater rainfall. However, this provides a small factor of safety, which is to the good. (See Vol. II, Appendices D-II and D-III.)

38. *Items that make up the revenue forecast.*—Having obtained the figures of probable summer and winter irrigation, these were distributed between the Crown waste and proprietary areas, as described in the appendices concerned.

The next point was to consider what might be expected ultimately, in the way of increased revenue, from the Crown waste and proprietary areas.

The following items make up the revenue forecast :—

- (1) Land revenue.
- (2) Abiana or water-rate.
- (3) Interest on sales of Crown waste-lands.
- (4) Rent for temporary leases of Crown waste lands.
- (5) Malikana.

The first two items are common to Crown waste and proprietary areas. The remaining are peculiar to Crown waste areas only.

It is, therefore, necessary to make separate revenue forecasts for the Crown waste, and the proprietary areas.

Land revenue is a form of tax on the owners of land, the rate depending upon the general productivity of the land in question.

Water-rate is, in reality, a charge for services rendered by the supply of canal water. It takes the form of a rate per acre matured, varying with the nature of the crop.

39. *Disposal of Crown waste.*—The Crown waste area is disposed of partly at concession rates in deserving cases, and partly by sales to the highest bidders. The concession area is set aside for peasant grantees and as rewards for military services and for those who have lost their land under the new canals or by waterlogging, etc. The terms for such cases are extremely liberal, and really amount to the partial giving away of the land in question. The balance of the land, about one half, is reserved for sale to capitalists, and it is on this area that Government expects to obtain the full market value. The prices obtained are, generally, high, because non-agriculturists are permitted to buy land at auction sales and this is a privilege which is prized by such communities.

40. *Interest on sales of land—how accounted for?*—Interest on sales of Crown waste lands is the interest, which is credited to the canal project and is calculated at a rate specified by the Government on the accumulated capital value of the Crown waste areas actually sold. The actual price obtained for land sold is not credited to the canal project, and the money is used as Government considers best. The interest, however, is credited, in perpetuity, to the canal project. It is thus clear that the capital value may be spent, but still the interest goes on being credited. It is, therefore, a book credit only, albeit, a justifiable one.

41. *Rents for temporary leases.*—Owing to commercial depression, the sales of land are, at present, slow. The land, which is not sold each year, is given out on temporary leases, usually for periods varying from 1 to 4 years. Cash rents, received for such temporary leases, are credited to the project.

42. *Malikana from land to peasant grantees.*—When land is given out on peasant terms, Government charges for the first 11 years a seigniorage or overlord rate called "malikana." This rate is a very moderate one, and much below the true rental value of the land. From the 11th year onwards, an additional amount is added, so as to allow the occupier to purchase the land in a period of 30 years or so, for a very moderate yearly payment, which he can defray from the produce of the land.

43. *Crown waste land, available for colonization, determined by soil survey.*—In the Haveli tract, there is an area of 220,000 acres of Crown waste land which, at present, does not receive canal irrigation. Practically, the whole of this area has been soil-surveyed and those portions of it, which have been found to be good land, are included in the financial forecast. The total area of good land included is about 101,000 acres. It is probable that much of the remaining area of 119,000 acres will in the course of time, gradually and slowly, come under cultivation, but only a small financial benefit is claimed from 23,000 acres of this inferior land in the forecast (see Vol. II, Appendix E-I).

On the Pakpattan canal, the area reserved for sale to capitalists is about 370,000 acres, and on the Burala Branch Extension, it is about 31,000 acres.

44. *Hidden reserve.*—In the forecast of this project, the actual area of Crown waste land shown as sold is only a small fraction of the total area available: hence the Punjab will have, in their possession, a hidden reserve of a few hundred thousand acres of valuable Crown waste land unsold.

45. *Land revenue.*—Detailed orders of Government on land revenue rates, to be charged in the various tracts concerned, are given in Vol. II, Appendices E-II, E-V and E-VI.

In the Haveli perennial proprietary tracts, a flat rate of Rs. 2 per acre replaces the existing varying rates. In the Haveli non-perennial areas, there is to be no change. But as the area irrigated will increase, the total land revenue will also increase.

On the Pakpattan canal the existing rate will remain.

On the Burala Branch Extension moderate increases have been approved.

46. *Water rates.*—The water rates proposed for the perennial areas (see Appendix E-II) are lower than those in force on the Sutlej Valley canals, although the supplies of water are more favourable. The water rates for winter crops have been kept low, with the purpose of encouraging the continued use of existing wells. It is, also, proposed to modify the present lump sum yearly tax on wells in the perennial area. It is, therefore, believed that the present moderate demands, coupled with a favourable water supply, should result in a contented peasantry. On the other hand, owing to the profitable utilization of the Ravi water in the Pakpattan canal, Government will be able to get the necessary revenue to pay for the capital expenditure involved.

47. *Forecast shows net increased revenue.*—In framing the revenue forecast, a deduction has been made for the actual revenue received at present from the existing canals, and also, for the increased cost of maintaining the more expensive and elaborate system of canals proposed. The revenue shown as earned by the project is, therefore, really net increased revenue, over and above that obtained at present (see Vol. II, Appendix E-III).

48. *Forecast revenue rates as approved by Government.*—The opinion and orders of the Civil Revenue authorities have been obtained on all data, affecting the revenue forecast and are contained in Vol. II, Appendices E-I to E-VI.

The final orders of the Government regarding principal items, on which the forecast is based, are summarised below :—

For the Haveli Canals.

Sale value for perennial Crown waste land	..	Rs. 250 per acre.
Rent for temporary leases of perennial good lands		Rs. 8 per acre allotted.
Rent for temporary leases of perennial inferior lands.		Rs. 8 per acre allotted.
Rent for temporary leases of non-perennial good lands.		Rs. 8 per acre allotted.
Malikana on peasant grants for perennial lands	..	Rs. 2 per acre allotted.
Malikana on peasant grants for non-perennial lands		Re. 1 per acre allotted.
Composite land revenue rate on proprietary perennial lands (including well surcharge at Re. 0-8-0 per acre on half the winter crops).		Rs. 2-15 per acre matured.
Composite land revenue rate on the proprietary non-perennial lands (excluding fixed lump sum well assessment).		Rs. 1-87 per acre matured.
Land revenue rate on Crown waste perennial lands		Rs. 8 per acre matured.
Land revenue rate on Crown waste non-perennial lands.		Re. 1-8-0 per acre matured.
Composite water-rate for perennial areas	..	Rs. 3-86 per acre matured.
Composite water-rate for non-perennial areas	..	Rs. 3-15 per acre matured.

For the Pakpattan Perennial Canal.

Increase in the value of Crown waste lands	..	Rs. 50 per acre.
Increase in rent for temporary cultivation	..	Rs. 2 per acre allotted.
Land revenue rate for Crown waste land	..	Rs. 3-8-0 per acre matured.
Composite water-rate	.. ..	Rs. 4-18 per acre matured.

For the Burala Branch Extension.

Increase in the value of Crown waste lands	..	Rs. 125 per acre.
Increase in rent for temporary cultivation	..	Rs. 3 per acre allotted.
Rent for temporary cultivation of new areas	..	Rs. 8 per acre allotted.
Increase in malikana on peasant grants	..	Re. 1 per acre allotted.
Land revenue rate on Crown waste lands	..	Rs. 8 per acre matured.
Land revenue rate on proprietary perennial lands		Re. 1-12-0 per acre matured.
Composite water-rate	.. ..	Rs. 4 per acre matured.

PART IV.—WATERLOGGING.

49. *Existing sub-soil water levels.*—Maps Nos. 2 and 3 show the depths of sub-soil water levels as observed in the Haveli canals area in June, 1934, before the commencement of the rains and in October, 1934, after the monsoons were over.

As shown in Vol. II, Appendix D-I, rainfall in the Haveli tract is practically negligible. The sub-soil water depths below natural surface show that there can be no objection to perennial irrigation being given to the area for which it has been provided.

50. *Comparison between the Upper Bari Doab and the Haveli perennial areas.*—In tracts, where old established canals exist, the sub-soil water-table is, generally, found to be constant over a period of years. There is a rise in October and a fall in June. In years of heavy rainfall, there will be a rise both in October and June, as compared with years of scanty rainfall. There is, however, no progressive rise. This stability in sub-soil water-table exists on the Upper Bari Doab canal, where the land is served with a good perennial canal water supply. (See statements, pages 14 and 15). Similar stability exists on the Sidhnai canal. Further, on the Upper Bari Doab canal the stable conditions exist in areas where wells are not prevalent and are not used. In the Sidhnai area we have the additional factor of safety in that it will still be necessary for the wells to be worked to mature the crops.

51. In conclusion, attention is drawn to the statements given below. In these statements, a comparison has been made between the Haveli and the Upper Bari Doab tracts :—

PARTICULARS.	Upper Bari Doab Canal (average of 4 years 1929-30 to 1932-33).	Proposed Haveli Canals (Perennial).
<i>1st July to 30th September.</i>		
Gross area commanded (acres) ..	1,625,485	694,278
Discharge at canal head (cusec-days) ..	484,769	253,000
Average depth of canal water on the gross area commanded (inches) ..	7.07	8.64
Mean rainfall during the period (inches) ..	15.76	7.59
Total depth of canal water <i>plus</i> rainfall (inches) ..	22.83	16.23
<i>1st October to 31st March.</i>		
Gross area commanded (acres) ..	1,625,485	694,278
Discharge at canal head (cusec-days) ..	507,852	315,179
Average depth of canal water on the gross area commanded (inches) ..	7.40	10.76
Mean rainfall in this period ..	4.62	1.03
Total depth of canal water <i>plus</i> rainfall (inches) ..	12.02	11.79
<i>1st April to 30th June.</i>		
Gross area commanded (acres) ..	1,625,485	694,278
Discharge at canal head (cusec-days) ..	551,532	250,250
Average depth of canal water on the gross area commanded (inches) ..	8.05	8.55
Mean rainfall during the period (inches) ..	2.28	0.84
Total depth of canal water <i>plus</i> rainfall (inches) ..	10.33	9.39

July to September is the period of the year, when the greatest rise in sub-soil water levels occurs due to canal and rain water, combined with the cessation of infiltration into the rivers. The canal water used for a period of 4 years—1929 to 1933—has been converted into depth of water over the gross area for the Upper Bari Doab canal and this added to the rainfall gives the total supply of water in inches.

We see that from July to September the total water spread on the Upper Bari Doab area is 22.83 inches as compared to a probable supply of 16.23 inches for the Haveli perennial area.

From October to March, the Upper Bari Doab area gets 12.02 inches as against 11.79 inches for the Haveli area. From April to June, the Upper Bari Doab gets 10.33 inches as compared with 9.39 inches in the Haveli perennial area.

52. We see that the Upper Bari Doab area is covered with a greater depth of water than the Haveli project area and has less wells, and still has a stable sub-soil water-table. These facts suggest that the fear of waterlogging south of the Ravi is unfounded, except in the vicinity of the four proposed canals connecting Abdul Hakim headworks to the present Sidhnai canals. (Depths of sub-soil water-table below N. S. for the Upper Bari Doab canal area are shown in Maps Nos. 4 and 5.)

53. *Provision made in the 1935 project for anti-waterlogging measures.*—In addition to the above, the only area, in which special measures are required to combat the risk of waterlogging, is the triangular tract to the north of the Ravi, bounded by the main canal and the Chenab and the Ravi rivers, the latter of which lies on a ridge. The main canal is large. In reaches, it is in very heavy filling, and it will be continuously in flow. An estimate for lining this canal was prepared, but it was eventually decided to deal with the problem by providing masonry core-walls in the high embankment reaches of the canal and by a good system of surface drainage, for which adequate money provision has been made in the estimate.

PART V.—PROGRAMME OF CONSTRUCTION AND ESTABLISHMENT REQUIRED.

54. *Summary of units.*—In Part II of this report, the 5 units, which comprise the project, have been dealt with in a general manner. These are—

	<i>Estimated cost.</i>
The Trimmu headworks on the Chienab ..	Rs. 2,29,82,000
The Abdul Hakim headworks on the Ravi ..	Rs. 39,02,000
The Left Bank canals	Rs. 1,75,88,000
The Right Bank canals	Rs. 79,07,000
The Montgomery-Pakpattan Link	Rs. 11,96,000
Total	Rs. 5,35,55,000

55. *Programme of works.*—The programme of works during the construction period is given in Vol. II, Appendix F-I. The work is expected to commence late in 1936. The Trimmu headworks will be completed in the fifth year, after construction begins. The financial statements have been prepared for ten years, subsequent to the completion of the Trimmu headworks although the works on the canal systems may take a year or two longer. This is again a factor on the side of safety, in assessing the productivity of the Project.

When a project is closed, it is always necessary to make out a list of works which have not been started or completed,—*vide* paragraph 33 of Appendix V, Public Works Department Code, 1st Edition. These lists show the unfinished portions of the project. It is very desirable to close a project as soon as the canals are opened. Hence many items are left over for gradual completion, after the project estimated itself is closed.

56. *Forecast of yearly expenditure.*—In making a forecast of expenditure, year by year, the above was borne in mind, and in addition the fact that the expenditure estimate is very liberal was also considered. The forecast shows that a sum of Rs. 68,20,000 is to be spent after the seventh year. A considerable portion of this amount represents money which it is hoped will not be spent, and the remainder is for works left over, as explained above.

In framing this forecast we were guided by the yearly expenditure incurred on the Sutlej Valley project and the amounts allowed in the peak years represent the maximum that can possibly be spent without undue extravagance.

57. *Engineering establishment required.*—In connection with the programme of works, a statement of the probable engineering establishment required is also given in Appendix F-II. The total amount of work to be done is more than can be dealt with by one construction circle. The heavy construction expenditure on the headworks and main canal will make it impossible for one Superintending Engineer to devote any attention to the remodelling of existing Sidhnai and Inundation canals. On the other hand, these canals are, at present, included in the single Multan Canals division. It is clear that the remodelling of one division will be too light a charge for a construction circle.

A few years back, the administration of the Sutlej Valley canals was reorganised, and the canals were put in the charge of two Superintending Engineers. These two circles are heavy, but the charges are not big enough to be split up into three circles. A possible solution is to take away one canal division, which lies alongside the Multan canals, from the Sutlej Valley canals and give it to the second Haveli circle. This will afford the necessary relief to the Sutlej Valley circle, and at the same time will provide sufficient additional work for the second Haveli circle.

Sanction is, therefore, required for the following scale of establishment ;—*vide* Vol. II, Appendix F-II:

During construction, 2 Superintending Engineers, 7 Executive Engineers, and 25 Sub-Divisional Officers.

After construction, permanent increase; one Superintending Engineer, 3 Executive Engineers, and 7 Sub-Divisional Officers.

58. *Reorganization of canal administrations.*—The Multan Canals division is in the Derajat circle, which is at present in the Southern Administration. Sanction has, however, been received to the transfer of the Derajat circle to the Construction Administration, as the Haveli project deals with areas within it and it lies alongside the Sutlej Valley canals, making a compact block. The whole of the area in the Construction Administration lies more or less in the central Punjab. The term "Construction Administration" is not entirely a happy one, because this administration will deal not only with construction, but also with revenue canals. It will, therefore, be more convenient to call it "The Central Canal Administration." There will then be 3 canal administrations in the Punjab—North, South and Central—and the Central Administration will deal with the Sutlej Valley canals, the Derajat Inundation canals, and the Haveli project.

59. *Conclusion.*—It is of importance that early intimation be given of sanction to this project so that work may start without delay. In the Punjab the working season is from October to May. The climate is so inclement in the 4 summer months that little can be accomplished and accurate surveys are impossible. The work will be dependent largely on Pathan Gilzai labour with their donkeys, and this labour will not stay down in the plains during the summer. If the work can be started by end of 1936 it will be possible to complete the railway and the buildings that are essential for the summer, and do the necessary surveys, start the flood embankments so that in the succeeding winter the work will be in full swing. A delay of a few months will mean the loss of a year's progress.

ACKNOWLEDGMENT OF SERVICES.

60. I would like to bring on record the good work done by the special staff appointed to deal with this project. While every man has done his best, I would draw special attention to the excellent work done by Mr. Kanwar Sain, Executive Engineer, and Bawa Sewa Singh, his Stenographer. Ch. Hukam Chand, the Head Draftsman, Pt. Ramji Das, the Assistant Clerk, and L. Arjan Mal, the Zilladar. The whole staff have worked for a period of 3 months, late and early without availing of any holidays.

Mr. Kanwar Sain, Executive Engineer's intelligence and guidance to his staff have been of a very high order.

The following staff was employed on this work :—

Clerical.

Bawa Sewa Singh (3), Stenographer.
Pt. Ramji Dass (2), Assistant Clerk.
Th. Shiv Dev Singh, Temporary Clerk.

Drawing Establishment.

Chaudhri Hukam Chand, Head Draftsman.
L. Ram Nath, Draftsman.
Q. Ghulam Qadir (2), Draftsman.
M. Atta Muhammad, permanent Tracer and Acting Draftsman.
L. Mohr Chand, temporary Draftsman.

Zilladar.

Lala Arjan Mal, Zilladar.

FINANCIAL STATEMENTS.

STATEMENT I.

HAVELI PROJECT, 1935.

FORM I.—FINANCIAL STATEMENTS.

PART I.—SUMMARY OF DIRECT CHARGES TO CAPITAL ACCOUNT.

Year.	Works	Establishment.	Leave Salary and Pension charges.	Tools and Plant.	Suspension.	Total.	Less Receipts on Capital Account.	Net total.
1	2	3	4	5	6	7	8	9
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1st ..	10,00,000	75,000	9,000	10,000	+1,00,000	11,94,000	..	11,94,000
2nd ..	40,00,000	0,25,000	1,10,000	1,00,000	+5,00,000	56,11,000	50,000	55,91,000
3rd ..	80,00,000	10,00,000	1,25,000	2,50,000	+10,00,000	1,03,75,000	50,000	1,03,25,000
4th ..	80,00,000	10,50,000	1,31,000	1,50,000	+15,00,000	1,08,31,000	50,000	1,07,81,000
5th ..	1,00,00,000	10,00,000	1,25,000	1,00,000	—10,00,000	1,02,25,000	50,000	1,01,75,000
6th ..	60,00,000	8,00,000	1,00,000	70,000	—10,00,000	59,70,000	2,00,000	57,70,000
7th ..	30,00,000	3,00,000	00,000	13,000	—4,00,000	29,73,000	3,00,000	26,73,000
8th ..	20,00,000	3,00,000	00,000	..	—3,00,000	20,00,000	3,00,000	17,00,000
9th ..	16,00,000	1,10,000	35,000	..	—2,00,000	14,51,000	1,00,000	13,51,000
10th ..	15,00,000	1,00,000	30,000	..	—1,00,000	15,30,000	1,00,000	14,30,000
11th ..	10,00,000	1,00,000	22,000	..	—50,000	10,72,000	00,000	0,73,000
12th ..	8,20,000	1,03,000	8,000	..	—50,000	8,86,000	..	8,86,000
13th ..	..	..	..	..	..	..	..	..
14th ..	..	..	..	..	..	..	..	..
15th ..	..	..	..	..	..	..	..	..
Total ..	4,68,20,000	58,71,000	8,21,000	6,03,000	..	5,42,03,000	12,90,000	5,20,00,000

STATEMENT II.

HAVELI PROJECT, 1935.

FORM I.—FINANCIAL STATEMENTS.

PART II.—SUMMARY OF INDIRECT CHARGES TO CAPITAL.

Year.	Capitalized abatement of Land Revenue.	Charges for Audit and Accounts.	Total.	REMARKS.
1	2	3	4	5
	Rs.	Rs.	Rs.	
1st	2,000	10,000	12,000	
2nd	10,000	10,000	50,000	
3rd	50,000	80,000	1,30,000	
4th	75,000	80,000	1,55,000	
5th	40,000	1,00,000	1,40,000	
6th	20,000	00,000	80,000	
7th .. .. .	..	30,000	30,000	
8th .. .. .	..	20,000	20,000	
9th .. .. .	..	15,000	15,000	
10th .. .. .	..	15,000	15,000	
11th .. .. .	..	10,000	10,000	
12th .. .. .	..	9,000	0,000	
13th .. .. .	..	..	..
14th .. .. .	..	..	..
15th .. .. .	..	..	..
Total ..	1,97,000	4,00,000	0,00,000	

HAVELI PROJECT, 1935.

FORM I—FINANCIAL STATEMENTS.

PART III—ESTIMATE OF GROWTH OF IRRIGATION AND REVENUE RECEIPTS AND CHARGES.

Year.	ASSESSED AREA AT THE END OF YEAR.		MONTGOMERY-PANPATAN LINE.				BURIA BRANCH EXTENSION.				HAVELI CANALS.				GROSS REVENUE DUE TO THE PROJECT.				Deduct working expenses and increased cost of Civil Ad- ministration and Appendix B-III) revenue as per	Net revenue due to the Project including indirect revenue.
	Mont- gomery- Panpatan Link.	Burial Branch Extension.	Haveli canals.	Direct receipts.	Indirect revenue.	Total.	Direct receipts.	Indirect revenue.	Total.	Direct receipts.	Indirect revenue.	Total.	Direct receipts.	Indirect revenue.	Total.					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
	Acres.	Acres.	Acres.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.			
4th year	120,000	18,000	672,541	79,560	5,23,660	6,02,500	39,980	1,26,001	1,66,581	24,17,344	14,31,344	30,88,405	79,560	5,23,660	6,02,500	..	6,02,500			
5th year	120,000	18,000	672,541	1,59,120	5,83,950	7,43,070	78,000	1,96,009	2,71,060	24,17,344	14,31,344	38,61,588	1,59,120	5,83,950	7,43,070	..	7,43,070			
6th year	120,000	18,000	672,541	2,77,540	6,97,200	9,74,740	1,09,100	2,61,174	3,70,334	25,18,141	15,57,640	40,73,790	22,78,109	19,51,677	42,29,786	33,00,000	9,29,786			
7th year	120,000	18,000	672,541	3,63,320	8,05,200	11,68,520	1,09,100	3,11,174	4,20,334	25,97,871	16,89,103	42,86,074	28,88,064	24,35,613	53,24,277	33,00,000	25,55,674			
8th year	120,000	18,000	672,541	5,01,600	9,07,950	14,09,550	1,09,100	3,11,174	4,20,334	26,98,547	18,33,611	45,32,158	31,28,901	27,26,773	58,55,674	33,00,000	28,26,868			
9th year	120,000	18,000	672,541	5,01,600	9,27,950	14,29,550	1,09,100	3,62,488	4,71,618	26,98,547	18,33,611	45,32,158	32,08,031	29,18,227	61,26,858	33,00,000	31,32,236			
10th year	120,000	18,000	672,541	5,01,600	9,48,950	14,50,550	1,09,100	3,89,488	4,98,648	27,78,036	19,65,944	47,43,980	33,88,796	31,23,940	64,33,256	33,00,000	33,93,178			
11th year	120,000	18,000	672,541	5,01,600	9,68,950	14,70,550	1,09,100	4,06,988	5,16,148	28,70,845	20,94,228	49,71,073	34,90,665	33,04,382	68,03,178	33,00,000	36,00,771			
12th year	120,000	18,000	672,541	5,01,600	9,80,950	14,92,550	1,09,100	4,24,488	5,33,648	29,68,008	21,78,825	51,37,433	35,60,368	34,70,166	69,06,771	33,00,000	38,03,631			
13th year	120,000	18,000	672,541	5,01,600	10,20,950	15,22,550	1,09,100	4,41,088	5,51,148	30,36,112	22,90,186	53,26,331	36,40,962	37,23,137	73,73,029	33,00,000	40,73,029			
14th year	120,000	18,000	672,541	5,01,600	10,72,950	15,74,550	1,09,100	4,60,488	5,69,048	31,41,080	23,61,210	54,62,290	37,61,840	38,03,648	76,15,488	33,00,000	43,15,488			
15th year	120,000	18,000	672,541	5,01,600	10,72,950	15,74,550	1,09,100	4,60,488	5,69,048	31,41,080	23,61,210	54,62,290	37,61,840	38,03,648	76,15,488	33,00,000	43,15,488			

Column 2 is obtained from Appendix E-V, Statement V, column 2.

Column 3 is obtained from Appendix E-VI, Statement VI, column 2.

Column 4 is obtained from Appendix E-IV, Statement IV, column 6.

Columns 5, 6 and 7 are obtained from Appendix E-V, Statement V, columns 3, 4 and 5, respectively.

Columns 8, 9 and 10 are obtained from Appendix E-VI, Statement VI, columns 3, 4 and 5, respectively.

Column 11 is obtained by summing up columns 7 and 8 of Statement VII of Appendix E-IV.

Column 12 is obtained by summing up columns 9 and 10 of Statement VII of Appendix E-IV.

Column 13 is obtained from Appendix E-IV, Statement IV, column 11.

Column 17 is obtained from Appendix E-III.

Sd/- M.L. Darling.

Financial Commissioner, Development, Punjab.

(Signed copy received with Senior Secretary to Financial Commissioner, Development, Punjab, U.O. No. 2135-C, dated 20th April 1936.)

STATEMENT IV.

HAVELI PROJECT, 1935.

FORM I.—FINANCIAL STATEMENTS.

PART IV-A (EXCLUDING INDIRECT OUTLAY).—ESTIMATE OF NET FINANCIAL RESULTS 10 YEARS AFTER DATE OF COMPLETION OF PROJECT.

Year.	Direct outlay during year.	Direct outlay end of year.	Simple interest at 6 per cent.	Net revenue.	Simple interest less net revenue.	Net revenue less simple interest.
1	2	3	4	5	6	7
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1st	11,01,000	11,04,000	35,820	..	35,820	..
2nd	55,91,000	67,85,000	2,39,370	..	2,39,370	..
3rd	1,03,25,000	1,71,10,000	7,10,850	..	7,16,850	..
4th	1,07,81,000	2,78,01,000	13,50,030	0,02,560	7,47,470	..
5th	1,01,75,000	3,80,60,000	10,78,710	7,43,070	12,35,640	..
6th	57,70,000	4,38,30,000	24,57,000	0,29,780	16,27,274	..
7th	20,73,000	4,65,33,000	27,10,350	20,24,277	0,80,073	..
8th	17,60,000	4,82,03,000	28,44,780	25,55,674	2,80,100	..
9th	13,51,000	4,06,44,000	20,38,110	28,20,858	1,11,252	..
10th	11,30,000	5,10,74,000	30,21,540	31,33,250	..	1,11,716
11th	9,73,000	5,20,47,000	30,03,030	33,03,178	..	2,00,548
12th	8,80,000	5,20,33,000	31,40,400	30,60,771	..	5,11,371
13th .. ..	..	5,20,33,000	31,75,080	38,03,031	..	0,87,051
14th .. ..	..	5,20,33,000	31,75,080	40,73,020	..	8,97,010
15th .. ..	..	5,20,33,000	31,75,080	43,15,188	..	11,39,503

Column 2 is obtained from Financial Statement I, column 9.

Column 4—interest has been calculated at 6 per cent. on the full amount of the outlay up to the previous year and half amount for the current year.

Column 5 is obtained from Financial Statement III, column 18.

STATEMENT V.

HAVELI PROJECT, 1935.

FORM I.—FINANCIAL STATEMENTS.

PART IV-B (INCLUDING INDIRECT OUTLAY).—ESTIMATE OF NET FINANCIAL RESULTS 10 YEARS AFTER DATE OF COMPLETION OF PROJECT.

Year.	Direct outlay during the year.	Indirect outlay during the year.	Total outlay during the year.	Accumulated outlay upto end of year.	Interest 6 per cent. (simple).	Net revenue.	Simple interest less net revenue.	Net revenue less simple interest.
1	2	3	4	5	6	7	8	9
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1st	11,01,000	12,000	12,00,000	12,00,000	30,180	..	30,180	..
2nd	55,91,000	60,000	60,41,000	08,17,000	2,41,500	..	2,41,500	..
3rd	1,03,25,000	1,30,000	1,04,55,000	1,73,02,000	7,21,470	..	7,21,470	..
4th	1,07,81,000	1,55,000	1,09,36,000	2,82,78,000	13,50,200	0,02,560	7,03,010	..
5th	1,01,75,000	1,40,000	1,03,15,000	3,85,53,000	20,03,730	7,43,070	12,60,660	..
6th	57,70,000	80,000	58,50,000	4,44,03,000	24,88,080	9,20,786	15,68,804	..
7th	20,73,000	30,000	27,03,000	4,71,00,000	27,45,270	20,24,277	7,20,003	..
8th	17,60,000	20,000	17,80,000	4,88,80,000	28,70,700	25,55,674	3,21,080	..
9th	13,51,000	15,000	13,66,000	5,02,62,000	29,74,140	28,20,858	1,47,282	..
10th	11,30,000	15,000	14,45,000	5,16,97,000	30,68,470	31,33,250	74,786	..
11th	9,73,000	10,000	9,83,000	5,26,80,000	31,31,310	33,03,178	2,61,868	..
12th	8,80,000	9,000	8,89,000	5,35,95,000	31,87,050	30,00,771	..	4,70,121
13th .. ..	..	..	..	5,45,75,000	32,14,500	38,03,031	..	0,40,131
14th .. ..	..	..	..	5,55,75,000	32,14,500	40,73,020	..	8,58,520
15th .. ..	..	..	..	5,65,75,000	32,14,500	43,15,188	..	11,00,088

Columns 2 and 3 are obtained from Financial Statements I and II.

Column 6—interest has been calculated at 6 per cent. on the full amount of the outlay up to the previous year and half amount for the current year.

Column 7 is obtained from Financial Statement III, column 18.

HAVELI PROJECT, 1935.

FINANCIAL STATEMENTS.

ESTIMATED FINANCIAL RESULTS.

Year.	Cumulative capital outlay direct and indirect to end of year.	Simple interest on direct outlay during the year.	Cumulative interest to end of year on direct outlay.	Net revenue during year,	Cumulative net revenue to end of year.	Sum at charge at end of year.	Percentage return on sum at charge.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1st	12,06,000	83,820	35,820	..	..	12,41,820	..
2nd	68,47,000	2,39,870	2,75,190	..	..	71,22,190	..
3rd	1,73,02,000	7,16,850	9,91,040	..	..	1,82,98,040	..
4th	2,82,38,000	13,50,080	23,41,070	6,02,560	6,02,560	2,99,76,510	20
5th	3,85,58,000	19,78,710	43,19,780	7,43,070	13,45,630	4,15,27,150	18
6th	4,44,63,000	24,57,060	67,76,840	9,29,786	22,75,416	4,89,04,424	19
7th	4,71,06,000	27,10,350	94,87,190	20,24,277	42,99,693	5,22,98,197	39
8th	4,88,86,000	28,41,780	1,23,31,970	23,55,674	68,55,367	5,48,62,603	47
9th	5,02,32,000	29,38,110	1,52,70,080	28,26,858	96,82,225	5,58,39,853	51
10th	5,16,97,000	30,21,540	1,82,91,620	31,38,266	1,28,15,481	5,71,73,189	55
11th	5,26,90,000	30,93,680	2,18,85,250	33,93,178	1,62,08,659	5,78,56,591	59
12th	5,35,75,000	31,49,100	2,45,94,650	36,60,771	1,98,69,430	5,82,40,220	63
13th	5,35,75,000	31,75,980	2,77,10,680	38,69,681	2,37,38,061	5,75,52,569	67
14th	5,35,75,000	31,75,980	3,08,86,610	40,73,029	2,78,06,090	5,66,55,520	72
15th	5,35,75,000	31,75,980	3,40,62,590	43,15,488	3,21,21,578	5,55,16,012	78

Column 2 is obtained from Financial Statement V, column 3. | Column 5 is obtained from Financial Statement III, column 18.
 Column 3 is obtained from Financial Statement IV, column 1. | Column 7 = column 3 + column 4 - column 6
 Column 8 shows the percentage of column 3 on column 7.

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